Name: _____ Date: _____ CHEM 1A

*Monday/Tuesday, November 25 & 26, 2019* -Bonding (All Chapter 13)

**I. Recall – Types of Bonding** - What is the difference between an ionic bond and a covalent bond?

1. Which of the following elements forms the most ionic bond with chlorine?
   (A) Rb (B) Ga (C) N (D) Ar (E) I

2. Which of the following groups contains no ionic compounds? (A) HCN, $SO_2$, $Ca(NO_3)_2$
   (B) $PCl_5$, LiBr, $Cu(OH)_2$ (C) NaOH, $CBr_4$, $SF_4$ (D) NaH, $CaF_2$, $NaNH_2$ (E)$CH_4O$, $H_2O$, $NBr_3$

3. Which of the following series is isoelectronic?
(A) B, C, N, O (B) $S^{2-}$, $Cl^-$, $K^+$, $Ca^{2+}$ (C) $F^-$, $Cl^-$, $K^+$, $Rb^+$ (D) Na, K, Rb, Cs (E) Sn, As, S, F

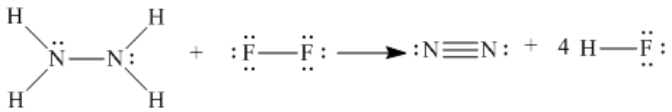
4. Order the following ions in size from smallest to largest: $S^{2-}$, $Cl^-$ , $K^+$ , $Ca^{2+}$, $Al^{3+}$, $Te^{2-}$ (Hint: Remember effective nuclear charge and how it affects atomic radii).

**II. The Energetics of Bonding**

**5.** (a) Draw Born-Haber cycle for the formation of strontium chloride.

(b) Use the following data to calculate the enthalpy of formation of strontium chloride. Write all thermo chemical equations for the steps of the cycle.
The enthalpy of sublimation of strontium = + 164 kJ/mol
First ionization energy for strontium = + 549 kJ/mol
Second ionization energy for strontium = + 1064 kJ/mol
The enthalpy of dissociation of chlorine, $Cl_2$ = + 243 kJ/mol
The electron affinity of chlorine, Cl = - 349 kJ/mol
Lattice energy of strontium chloride = - 2150 kJ/mol

6. Estimate the value of ΔH for the following reaction:



| Bond | Ave. Bond Energy (kJ/mol) |
|---|---|
| N–H | 391 |
| N–N | 160 |
| N=N | 418 |
| N≡N | 941 |
| F–F | 154 |
| H–F | 565 |

## III. Electronegativity & Molecular Polarity

**0 ----------0.4 ----------1.8**

**Electronegativity (χ):**

**Electric Dipole**:

**Polarizability (α)**:

1. Which of the following is ranked correctly in order of increasing electronegativity:
(A) Cl < Br < I (B) Al < Si < P (C) Li < Na < K

2. Rank the following bonds in order of increasing polarity.
I. C–O II. C–N III. C–F

3. As a general pattern, electronegativity is inversely related to
(A) ionization energy. (B) atomic size (C) polarity of the atom. (D) the number of neutrons in the nucleus.

4. In the gaseous phase, which of the following diatomic molecules would be the most polar?
(A) CsF (B) CsCl (C) NaCl (D) NaF (E) LiF

## IV. Drawing Lewis Structures

1. Draw Lewis Structures for the following compounds.

a. $BeF_2$

b. $PBr_3$

c. HCN

d. $H_2CO$

e. $ClO_4$

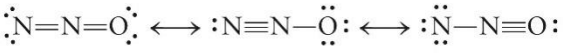
f. $SO_2$

g. $ICl_3$

2. For all the structures in IV-1, determine if formal charge can be minimized and draw the structure.

**Resonance:**

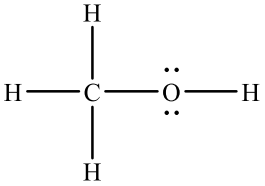
3. Which of the following resonance contributors for $N_2O$ is the most stable?

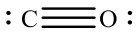


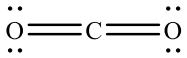
## V. Bond Strength & Length

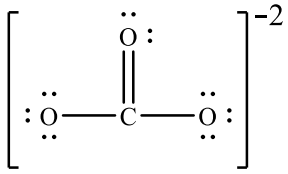
Rank the following in order of shortest to longest carbon oxygen bond length:

$CH_3OH$ $CO$ $CO_2$ $CO_3^{2-}$





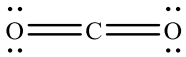




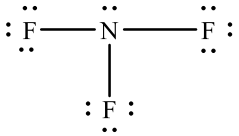
## VI. VSEPR Theory

5. Determine the molecular geometry and bond angle for the following:

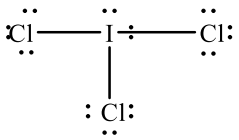
a. $CO_2$



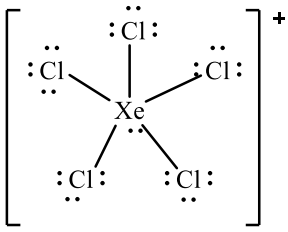
b. $NF_3$



c. $ICl_3$



d. $XeCl_5^+$



6. Which of the following are polar? Circle all that apply

a. $BF_3$ b. $NH_3$ c. $CCl_4$ d. $XeBr_4$ e. $H_2CO$

7. Go back and determine the molecular geometry & polarity of the molecules in question IV-1.

***Lewis Structure Guidelines:***

*1. Determine the number of valence electrons (group number, add electrons for anions or subtract electrons for cations)*
*2. Determine the central atom(s) – least electronegative element (exception - hydrogen will not be the central atom)*
*3. Draw out structure with single bonds symmetrically – add square brackets and charge for ions*
*4. Put 6 electrons (3 pairs) on each outer atom except hydrogen – put any remaining electrons on the central atom*
*5. Determine if all atoms have what they want (H ⇒ 2, Be ⇒ 4, B and Al ⇒ 6, and all else ⇒ 8) – if yes you're done – if not add a bond for every 2e- that's missing – the bonding electrons come from an adjacent atoms non-bonded pair – if there's more than one outer atom with lone pairs to share with the central is called resonance – the real structure is a hybrid of the possible resonance structures*
*6. Formal Charge = Group number – #bonds – #non-bonded electrons*
*7. Minimizing formal charge ⇒ only possible for molecules with a central atom in period > 2 ⇒ add a double bond between an outer negative atom and a positive central atom*